

COMMENCEMENT ADDRESS

SIXTY-THIRD ANNUAL COMMENCEMENT; DELIVERED THURSDAY, JUNE 20,
1907, BY IRA REMSEN, LL. D., PRESIDENT OF JOHN HOPKINS UNIVERSITY

In the year 1754 an advertisement of King's College, now Columbia University, appeared in a New York paper. A part of that advertisement reads thus:

"And, lastly, a serious, virtuous, and industrious course of life being first provided for, it is further the Design of this College, to instruct and perfect the Youth in the Learned Languages, and in the arts of numbering and in the arts of reasoning exactly and writing correctly, and speaking eloquently; and in the arts of numbering and measuring: of Surveying and Navigation, of Geography and History, of Husbandry, Commerce, and Government, and in the knowledge of all Nature in the Heavens above us, and in the air, Water, and Earth around us, and in the various kinds of Meteors, Stones, Mines, and Minerals, Plants, and Animals, and of everything useful for the comfort, the convenience, and Elegance of Life, in the chief Manufactures, relating to any of these things, and finally, to lead them from the Study of Nature to the knowledge of themselves, and of the God of nature, and their duty to him, themselves and one another, and everything that can contribute to their true happiness, both here and hereafter."

If a college education could accomplish all this one hundred and fifty years ago, what have we not a right to expect of it today? I fear, however, that there may have been as wide a gap then between the prom-

ise of the advertisement and the fulfillment as now-a-days we suspect may exist in the case of patent medicines. But, though experience has shown that colleges do not make men perfect, experience has shown that most of those who go to college are helped, though it is not always easy to say just how they are helped.

I do not propose to discuss this old subject, though it would be possible, I think, to say something helpful in regard to it. I will rather turn to a somewhat broader subject that is suggested by the circumstances under which I am called upon to speak to you.

In the hurry and worry of a college course there is danger that students may lose sight of certain problems of fundamental importance.

The pressure for more work in all departments is great and increasing, and there is little time for reflection. Yet no one will deny that reflection is desirable, and that it is essential if one is to get his intellectual bearings; and he must get his bearings in order that he may take a definite course on his life's voyage and avoid that aimless drifting so common among young men—and old for that matter.

Commencement day marks an epoch in the lives of students, and I believe they are on that day in a condition of mind favorable to the reception of some broader thoughts than those which have had possession of their minds especially during the few weeks immediately preceding the fi-

nal examination. In this belief I have thought it well to utilize the opportunity that has been given me to a few thoughts that have been taking shape in my own mind for some years past.

Not long ago a phrase was current in Paris that gave great satisfaction to some, and was unpleasant in the ears of others. Heated discussions were carried on on account of it, and it gave rise to a rather sharp division of learned men into two classes, the literary and the scientific. The phrase I refer to was taken up by a prominent literary man, and it became, in a way the battle cry of those who range themselves on his side.

You will perhaps be surprised to hear that the phrase is simply this: "Science is bankrupt." You will also be surprised to learn that this phrase was spoken seriously, and that it filled with enthusiasm a number of those who are generally looked upon as leaders in the intellectual world.

Now what does that phrase, "Science is bankrupt" mean? It means that science has failed to keep its promise; that it has not and cannot meet its obligations. Or, to use language somewhat less commercial, it has not accomplished what it set out to accomplish, and the world has been altogether disappointed in the results. It signifies further, that mankind has been led to hope that it was to be elevated by science, and mankind has not been elevated to any marked degree and science is responsible for this.

I should not think it worth while to spend any time in attempting to defend science against such attacks if I had not received evidence that the state of mind of our French friends is more common than I supposed it to be.

A few years ago I had the pleasure of listening to an oration delivered before a large audience under circumstances that gave great weight to all that was said. The orator is a liter-

ary man of high standing in this country. He, too, took occasion to sneer at science, and left upon the minds of the audience the impression that science is doing humanity a grievous harm. He would tremble to see social reform led by men who had "breathed" the scientific spirit.

In view of the facts mentioned, it has seemed to me that it might not be wholly unprofitable to spend the time at my disposal in a discussion of the question raised: Is the pursuit of scientific learning beneficial or injurious? If it is injurious, it is clear that we ought all to use our efforts to put a stop to it. But as a matter of fact, larger and larger numbers are engaging in scientific work year by year; larger and larger sums of money are being spent in the equipment of laboratories for scientific work; and the world is certainly becoming interested more and more in this kind of work. If it is to be stopped—and, if it is injurious, it must be stopped at all hazards—the sooner we reach this conclusion and begin to work in opposition the better, for the battle will be a long one the best we can do.

In any discussion it is well to begin with definitions; indeed, I am of the opinion that most discussions are due to misunderstanding, and that, if those who are interested would stop long enough to learn exactly what they mean they would shake hands and stop talking. What then, let me ask, is meant by the word science? The broadest definition of science is "knowledge; that which one knows." Or again, science is defined as "truth attained in a methodical study" and as "a knowledge of laws, principles and relations." Science is also sometimes defined as "organized knowledge." As used in this discussion the word means more especially natural science, that is to say, that branch of science which has to do with what we

call Nature. This distinction is not material for our purpose, for, so far as there has been developed a science of philology, of history, of literary criticism, of mental phenomena, the expression "Science is bankrupt" would probably be regarded as applicable to these by all who use the phrase at all. To illustrate the significance of the definitions given let me take as an example the particular science with which I am most familiar. How did chemistry ever come to be a science? It is not necessary to go back very far in the history of the world to find a time when there was no science of chemistry; and yet men have been familiar with many chemical phenomena from the earliest times. Those of fire, of fermentation in its various forms, of decay, are among the most common that present themselves. One can pick up considerable information in regard to chemical matters by keeping one's eyes open, but one cannot in this way develop the science of chemistry. That development is a slow process made possible by the labors of successive generations of those who devote themselves to the special study of chemical phenomena. It was only after this kind of study had been carried on for ages that the connection between the facts established came to be recognized, and the knowledge systematized. Then for the first time was there a science of chemistry. At first it was not much of a science, but as the work of investigation continued and, especially during the past hundred years, it has developed into one of the strongest among natural sciences. By the aid of the immense number of facts that have been discovered, general principles have been discerned underlying these facts. These principles or laws have in turn led to the discovery of other facts, and new principles have been revealed. Then too, the general principles or laws have led to specula-

tions in regard to the causes of these manifold phenomena, and some of these speculations have stimulated men to further work. Theories have come and theories have gone, but the great current of discovery of facts and laws has swept on, becoming deeper and broader the one object of the science of chemistry is the discovery of the truth pertaining to chemical phenomena so far as such discovery may be possible. The earth presents us with innumerable problems of the most interesting kind, and we have implanted in us the desire to know.

The pursuit of science is nothing but an expression of this desire. Is it not better to know than not to know? Would the world be better off than it is now, if scientific discoveries could be blotted out, and we could go back to the time before science was? These are the questions that must be answered. Does anyone seriously think that the world has been injured by increased knowledge? Do we not all believe that increased knowledge of the things around us must tend to make our actions more reasonable as we try to adjust ourselves to existing conditions?

What is the scientific method? It is the simplest conceivable method of dealing with problems whatever they may be. It consists in studying the facts in the case and then drawing conclusions from the facts. The great problem of science is to find out as much as possible in regard to the universe. The first thing to do is to get at the facts and to let them speak for themselves. Scientific investigation is primarily an organized effort to discover the facts. The desire to learn more and more in regard to his surroundings is natural to man. We see evidences of this desire in the infant and we may be sure that it has always existed. What we are pleased to call the advancement of the world is primarily due to the existence of this de-



IRA REMSEN, LL. D.
PRESIDENT OF JOHN HOPKINS UNIVERSITY
COMMENCEMENT ORATOR

sire. Take it away and advancement would surely stop. Of course the desire in itself is not sufficient. That furnishes one of the incentives—I think I may say the principal incentive—but it is the work to which this desire leads that is the chief factor in the development of knowledge.

In the early stages of the world, when man was in his primitive stages, knowledge of his environment was gained by the ordinary daily observations that he could not help making. By these observations much knowledge was accumulated. In the course of time, perhaps in the beginning, his imagination was brought into play and he began to conceive causes. What makes the wind blow, the rain to fall, the sun to shine, the heavenly bodies to move! Behind these phenomena he imagined beings something like himself—spiritual specialists—and, as these spirits were products of his imagination, there was no difficulty in adding to their number whenever a new set of phenomena calling for explanation came under observation.

Later, when these spirits failed to satisfy, theories began to come in and, during the philosophical period, speculation in regard to the unseen causes was rampant. Learned men then undertook to solve the problems of the universe by mental processes. There was some effort to connect these theories with the facts, but after all the theories were the main object in view and were regarded as altogether more interesting and more important than the facts. This was the period of speculation, the period of theories. No doubt this was a necessary period just as the period of childhood is necessary.

There was little encouragement for the worker in those days. He who used his hands was regarded as an inferior being, not fit to associate with gentlemen and scholars. Systems of philosophy were worked out that were

top-heavy. The basis of facts upon which they rested was too narrow to support them, and, one by one, they fell to earth again, and gradually by hard knocks, man learned that the only way to discover the secrets of the universe is by coming in direct contact with the things of the earth. The attic philosopher, the monk in his cell, cannot tell us what we want to know for they have shut themselves off from the source of knowledge. They may for a time continue to evolve thoughts suggested to them by observations made in the outer world, but sooner or later their material will give out and they will be threshing old straw.

We have not yet passed the speculative stage in which theories out of proportion to the facts are evolved; we have not yet passed the stage in which the suspicion exists in the mind of some that those who acquire knowledge by the experimental method, who therefore work with their hands, are somewhat inferior to those who only think and reason and speculate; but, on the whole, we have reached a stage in which the laboratory is playing a controlling part in the onward movement of the world. The scientific laboratory supplementing the more direct study of the outer world supplies us with information. One gives us great things, another gives us little, but everyone does something to help along the cause of learning. The laboratory helps in two ways. First, it shows the world how to deal with problems of every kind whether in the field of psychological phenomena or not, and second, it contributes to the stock of knowledge in the particular field cultivated by it.

In regard to the first proposition that the laboratory shows the world how to deal with problems of every kind, let me say a few words. I was talking recently with a leader in the industrial world and with a professor

of political economy. The former was very anxious to study certain phenomena pertaining to labor organizations, particularly the part played by them in connection with the development of industries. I was extremely interested in the conversation, as I got an insight into the methods of study adopted by the political economist. I learned that there are men in this branch who think that by writing a book on a subject they have necessarily contributed something of value to that subject, and that there are others who having caught the scientific spirit know that the first thing to do is to study the facts. I learned that most of those who have written on labor organizations started with a distinct bias; and, whether the bias was on one side or the other, each found enough in the facts to show that his views were right. That is not scientific. The true scientific investigator has no bias. He is in the jury. He is to hear the evidence and to give his decision in accordance with the facts.

So, too, I have heard, as you have, many a discussion on questions of national policy that showed clearly that the disputants were not dealing with their problems in a scientific way. Take, for example, the subjects of trusts and railway rates. The mere mention of them is quite sufficient to disturb the equilibrium of any audience or of any individual. There are deep subjects, so deep that it is extremely difficult, not to say impossible, to reach the bottom of them. Even those who have approached them in the most scientific, that is to say the least prejudiced, way have not always agreed in their conclusions. The great majority of us cannot possibly discuss these subjects satisfactorily. We can, to be sure, discuss them in the usual way. We can call our opponents names. But that is not the scientific method.

If the object of science is the dis-

covery of truth, in what sense can science be said to be bankrupt? The history of every branch of science furnishes evidence of the success that has attended the efforts of investigators. Surely the world cannot complain of the littleness of the results. To those engaged in scientific investigation, that which has been attained seems, to be sure, but little as compared with that which remains to be done, but, as compared with what was known a few hundred years ago, what is now known is of immense proportions. Steady accumulation has led to great wealth of knowledge. Science is not bankrupt. Draw freely upon her, my friends—the drafts will be honored.

It is clear that in the sense in which I have used the word science, it is impossible to conceive of a state of things in which science can ever be said to be bankrupt; and yet there is no other sense in which the word can properly be used. It is, however, used in other senses, though improperly, and here the difficulty begins. Probably the great majority think of science as something which furnishes mankind with a variety of useful devices—a telegraph, a telephone, a medicine, a dye-stuff, a perfume—and that in supplying these it is fulfilling its mission. According to these, scientific work that does not culminate in something “practical” is of little or no value, and therefore there is no excuse for it. No one will deny that it is desirable that the results of scientific investigation should be utilized to the fullest extent for the purpose of increasing the welfare of mankind. How far this welfare has been increased by this means I shall not attempt to point out. There is no danger that the world will not reap the benefit of the results of scientific work. For every one engaged in such work there are a hundred ready to make application of the results. I would, however, emphasize this point, that the pursuit of knowledge, which

is the object of scientific work, is one thing and application of the knowledge gained is another thing, for which science cannot be held responsible. Even if it could be said that not a single valuable practical application of the knowledge accumulated by science has been made, science as such could not be said to be bankrupt, for with the applications science has nothing to do.

But, assuming for the moment that the object of science is to give the world something practical—something to eat or drink, something to make killing easy, or something to delight the senses—I say, assuming that this is the proper view, how does the matter stand as regards the solvency of science! Plainly, science has nothing to fear from an examination of this kind. The fact is, such an examination reveals an embarrassment of riches. So great and so valuable are these applications that the world has been blinded by them, and has in consequence to a large extent been unable clearly to recognize the true character and the true field of scientific work.

Within the memory of those of us who are no longer members of the younger generation, marked improvement has taken place in many directions. The relations of man to man, of man to government, of government to government, have certainly improved. The bloody wars of conquest that at one time played such an important part in the development of man are practically things of the past. They may come again, but the signs indicate that this is improbable. Laws are becoming less oppressive. Justice is more easily obtained. The unfortunate of the race are more tenderly and more wisely cared for. It is no answer to this argument to say that there is still much crime, that there are conspicuous examples of corruption constantly being brought to our attention; that there is much

suffering among the people of the earth. The question is one of the averages; and I do not think that any one will seriously maintain that the world is going to the bad. In the general tendency of things then, there does not seem to be any reason for quarreling with science, for on the whole, the world appears to be improving.

One of the arguments formerly used most against science, was that it is antagonistic to religion; that the tendency of scientific work is to remove the veil from nature, to destroy her mysteries, and to lead to materialistic conceptions of the universe. We do not hear this argument now-a-days as much as a few years ago. It is coming to be recognized more and more clearly that science can do true religion no harm, but can only strengthen it. It may modify, and has modified, dogmatic theology. Theology is one thing and religion is another, and true religion must find a broader and broader foundation in knowledge. The more we know of the works of God, the more we must be impressed by his infinite greatness. The opposite view would appear to be sacriligious.

As regards the destroying of the mysteries of nature but one word. As I understand this expression its meaning may be illustrated by the following example: Water is a mysterious thing. Chemists have succeeded in showing that this mysterious thing consists of the two gaseous substances, oxygen and hydrogen, in certain proportions. The mystery is nothing but a compound of oxygen and hydrogen. But I submit that more questions are now suggested than the mere existence of water could suggest. We now have not one mystery but many. Nothing is more mysterious than the act by which hydrogen and oxygen combine to form water. We know practically nothing

about it. How is it that the two gaseous substances can be in an instant transformed into a liquid? Nothing more magical can be imagined. So, too, hydrogen and oxygen are, as we say, elements, but they are, in a way, even more mysterious than water. Of their nature we have no conception. To say that they are elementary forms of water is only to raise that deep question, what is an element? Or compare the old view that the earth is supported and stationary in space with the view so familiar, that it is one of the planets, and that these and all heavenly bodies act as though they are held together by some force operating according to a definite law. Which is the more inspiring? Is there less to stir the imagination in the conception of a force pervading the entire universe, is there less of mystery in this broader view? What is this universal force? We may say that it is gravitation, but this is only an evasion. It is not a helpful answer.

Scientific investigation, in answering certain questions, is raising a host of others. The mystery of the universe appears greatest to him who knows most about it. Its enormous complexity, the beauty of its adjustments, the efficacy of the forces that are at work to maintain it, the subtle changes that mark its activity, the far reaching operation of nature's laws, these are mostly hidden from those who have not made them a special study.

Then what are these materialistic conceptions that are the result of scientific work. I have never been able to understand what they are. Matter is absolutely incomprehensible to man. We know it only as it effects our senses. We cannot define it. If anyone should say to me that a knowledge of matter is all that we need to order to enable us to understand the universe, I should have to reply that I do not understand the statement, for

I have no conception what matter is. Our ideas of matter are so intimately connected with our ideas of energy or force that we cannot conceive of one without the other. Then suppose that we should admit that all science can hope to do and all that she attempts to do it to investigate the phenomena presented by matter and energy, is this equivalent to saying that this is the end? Not at all. The very existence of matter proves beyond a question that there must be a power infinitely greater than any that come within the range of our studies, however great and incomprehensible these may be to us. I do not see that there is any escape for this conclusion; and it is well to remember that this conclusion is forced upon us by the study of what we call matter.

But, you may say, all this is clear enough and simple enough. We grant that you are right, and yet we ought to turn back for a moment to a question or two that has been left unanswered, more especially to the question whether the world is helped or injured by increase of knowledge? It may be helped in a material sense and not in a higher sense. Just as we sometimes see the sons of rich parents injured by the possession of wealth, so it may be that mankind is injured by wealth of knowledge. So much is done for our comfort that we may be degraded in some other way in consequence. Though in one sense science is not responsible for the uses made of her store, yet, in the highest sense this is not the proper view to take of the subject, and I think all will agree that, if science contributed either directly or indirectly to the degradation of mankind, it must be held responsible. The plea that it has nothing to do with the results will not suffice.

Let us then next inquire whether, in the field of conduct, the results of scientific investigation are or are not wholesome? This is the highest test, and, plainly, the most difficult. I am

quite sure that no one can at present give a final answer to the question, be he a scientific or a literary man, historian, philosopher, or divine. Our knowledge of the facts is not sufficient. We can all express opinions and give reasons, good or bad, for our opinions. If one tells me that mankind has not been helped by science, I ask how do you know? If another tells me that mankind has been helped, I ask, how do you know? But the subject, however difficult it may be to deal with, cannot be dismissed in that way. Arguments on the one side and on the other are brought forward, and, as in a case at law, we try to form an opinion in accordance with the weight of evidence. If it can be shown that mankind is slowly advancing, that the average standard of conduct of mankind is improving, we shall, I think. It would perhaps be impossible to prove that science has had a hand in the improvement, but it can be shown that certain definite results have followed in the wake of increased knowledge, and it can at least be made to appear highly probable that scientific investigation is one of the great forces at work in modifying the conduct of men.

As regards the fundamental question whether mankind is improving or not, I believe most persons will answer this in the affirmative. The improvement may be slow, much slower than we should like to see it, but it is not sure? Every one who has even a superficial knowledge of history knows that the standard of conduct today is higher than it was a century or more ago.

There is an interesting story told of that medicine so dear to many of us under the name of quinine. This is now, and has long been, obtained from the bark of a tree that grows in Peru. The Peruvian Indians used the bark as a remedy against intermittent fevers. The wife of the viceroy of Peru, the Countess of Cinchon,

imported it into Europe in 1639, and it has hence come to be known as cinchona bark. It soon acquired a high reputation among the Jesuits and gradually among the people as a whole. In the present century, scientific investigation has shown that the bark contains a number of definite constituents some of which have the curative power of the bark, but in a much higher degree. The most conspicuous of these constituents is the alkaloid quinine. It is chiefly to this that Peruvian bark owes its value as a remedial agent. At present the bark is not generally used, but the "active principle" freed from the useless accompaniments is used in its stead. But, when the suggestion was first made to substitute the essential constituent for the indefinite concoction prepared directly from the bark, there is said to have been much opposition manifested by patients as well as by priests and doctors. They all wanted nature's remedy. They did not want the product of scientific work. The latter being the work of man could not be as efficacious as the natural bark. It required the efforts of years to convince the doubters that the action of the essential constituent of the bark is more reliable than that of the bark itself.

Is there not a deep lesson in this story? We are constantly being diverted from the essential by matters of detail. Truth comes to us in the form of bark, with its crystalline, essential constituents concealed from us. The tendency of scientific investigation is to reveal to us those essential constituents, and to lay them before us, that we may more clearly be guided in our efforts to find higher truths. But we constantly resent this interference of science, and wish to retain our bark. The history of the introduction of quinine finds its parallel in every advance in the realm of thought.

Is science bankrupt? If so, in what

sense? I have endeavored to find an answer to these questions. What answer will you give? Is the scientific spirit something to be feared? If the expression leading a reform in a scientific spirit means anything, it means leading the reform on the basis of knowledge. Other things being equal, one who understands mankind best will be the most likely to succeed as a reformer. One reason why so many reform movements fail so ignominiously is that they are not undertaken in a scientific spirit. Facts that are well established are ignored. The laws of human nature are lost sight of and in a most unscientific spirit plans are laid that must come to naught. Knowledge does not take away sympathy and the feeling of brotherhood, but it helps to prevent the sacrifice of those who are the victims of plans based upon ignorance.

It is not the special business of the scientific man to dream, and yet dream he will. Let me here tell you of a dream of a certain distinguished chemist. It has to do with changes that are to be brought about by the advance of chemical science. The results of investigations already accomplished indicate that, in the future, methods will perhaps be devised for the artificial preparation of food from the water and carbonic acid so abundantly furnished by nature. Agriculture will be unnecessary, and the landscape will not be disfigured by crops growing in geometrical figures. Water will be obtained from holes three or four miles deep in the earth, and this water will be above the boiling temperature, so that it can be used as a source of energy. It will be obtained in liquid form after it has undergone a process of natural distillation, which will free it from all impurities, including, of course, disease germs. The food stuffs prepared by artificial methods will also be free from microbes, and there will consequently be less disease than at present. Further, the neces-

sity of killing animals will no longer exist, and mankind will become gentler and more amenable to higher influences. Everywhere the means of subsistence will be available. Man, not finding it necessary to work as hard as he does at present to keep himself alive, will work to elevate himself intellectually and morally. Is this not a fascinating picture? And all that we need is a few holes bored into the earth the mere paltry distance of three or four miles. Here is an opportunity the like of which is not often offered. Who will take advantage of it? Thus far the French chemist.

I, too, have had a dream, but it did not have to do with food-stuffs nor with agriculture, but with things less material. I dreamed of the time when by continued scientific investigation man will more clearly recognize the truth whatever it may be; when he will more clearly see the relation of things; when he will have learned how to conduct himself under a given set of conditions so that the happiness of his fellowmen may be increased by his actions; when he will instinctively obey sanitary and moral laws; when he will recognize the essential truths underlying religions, and will be guided by them.

Science has no quarrel with literature any more than with religion. Art, of which literature is one branch, has, as we all know, a very important part to play; so, of course, has religion; and so, I maintain, has science. One does not interfere with the other, but all are working together, whatever some of their disciples may be inclined to think—working together for the uplifting of man. We need all these agencies, and even with them progress will be slow.

Finally, let me say that there are narrow-minded scientific men; as there are narrow-minded literary men; I suppose, and I have even heard of narrow-minded theologians. In every

class there are extremists. These are frequently the ones who talk and write the most, and hence their views are apt to be taken as representative.

But nothing is more unscientific than an extremist, and those who have tendencies in this direction would do well to breathe the scientific spirit.
